Part 27—Airworthiness Standards: Normal Category Rotorcraft

This change incorporates Amendment 27–34, Normal and Transport Category Rotorcraft Regulations, a technical amendment correcting some incorrect word usage and omissions, misspellings, and incorrect references. This amendment affects §§ 27.175, 27.351, 27.391, and 27.621.

Bold brackets enclose the most recently changed or added material in these particular sections. The amendment number and effective date of new material appear in bold brackets at the end of each affected section.

Page Control Chart

Remove Pages	Dated	Insert Pages	Dated
P–327	Ch. 4	P–327 through P–330	Ch. 5
Subpart B	Ch. 4	Subpart B	Ch. 5
Subpart C	Ch. 3	Subpart C	Ch. 5
Subpart D	—	Subpart D	Ch. 5

Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

Section 29.917—Design. The incremental costs to formalize existing design information for the rotor structure (§ 29.547 above) and drive system are estimated to total $47,000 per type certification. Formal identification and assessment of critical component failures of the rotor drive system will increase safety by providing more comprehensive maintenance information to operators. The benefits of averting a single accident caused directly or indirectly by a lack of relevant data would easily exceed the incremental costs.

Section 29.1587—Performance information. Since the required climb gradient data are already available from the results of flight tests required to obtain performance information, the only additional costs will be those associated with incorporating the data into the Flight Manual, estimated to total $6,000 per type certification. The availability and accuracy of performance data are paramount to operational safety. The benefits of averting a single accident caused directly or indirectly by a lack of relevant performance information will easily exceed the incremental costs.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal Regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed rule would have "a significant economic impact on a substantial number of small entities." Based on the criteria of FAA Order 2100.14A, the FAA has determined that the rule will not have a significant impact on a substantial number of small entities.

The rule will affect manufacturers of future type-certificated normal (part 27) and transport category (part 29) rotorcraft. For manufacturers, Order 2100.14A defines a small entity as one with 75 or fewer employees and a significant economic impact as annualized costs of $19,000 or more. The FAA has determined that the rule will not have a significant economic impact on a substantial number of small manufacturers since (1) no part 29 and only two part 27 rotorcraft manufacturers have 75 or fewer employees, and (2) the annualized certification costs of the rule are less than $19,000.

International Trade Impact Assessment

The rule will not constitute a barrier to international trade, including the export of American rotorcraft to other countries and the import of rotorcraft into the United States. Instead, the changes will harmonize with certification procedures of the JAA and thereby enhance free trade.

Conclusion

For the reasons discussed above, including the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not a significant regulatory action under Executive Order 12866. In addition, the FAA certifies that this regulation will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This regulation is considered nonsignificant under DOT Order 2100.5. A final regulatory evaluation of the regulation, including a final Regulatory Flexibility Determination and International Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

The Amendments

In consideration of the foregoing, the Federal Aviation Administration amends parts 27 and 29 of Title 14, Code of Federal Regulations (14 CFR parts 27 and 29) effective August 8, 1996.

The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

under 14 CFR parts 27 and 29. As published, the final regulations contain some incorrect word usage and omissions, misspellings, and incorrect references that may prove to be misleading and are in need of correction.

DATES: Effective November 28, 1997. Comments for inclusion in the Rules Docket must be received on or before September 29, 1997.

ADDRESSES: Submit comments in duplicate to the Federal Aviation Administration, Office of the Chief Counsel (AGC–200), Attention: Rules Docket No. 29008, 800 Independence Ave., SW., Washington, DC 20591.

Comments may also be submitted electronically to the following Internet address: 9–NPRM–CMTS@faa.dot.gov. Comments submitted must be marked: Docket No. 29008.

Comments may be examined in Room 915G on weekdays between 8:30 a.m. and 5:00 p.m., except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Mary June Bruner, FAA, Fort Worth, Texas 76193–0111, telephone (817) 222–5118, fax (817) 222–5961.

SUPPLEMENTARY INFORMATION: This action makes some nonsubstantive changes to various sections of parts 27 and 29. The affected parts, as published, contain some incorrect word usage and omissions, misspellings, and incorrect references. The FAA has determined that these changes are nonsubstantive and is not aware of any opposition to making these changes.

Further, the European Joint Aviation Authorities (JAA) has notified the FAA that they are issuing a Notice of Proposed Amendment (NPA) to make these same changes to the Joint Aviation Regulations (JAR) 27 and 29. Thus these changes to parts 27 and 29 will be harmonized with the JAA's NPA.

The FAA anticipates that this regulation will not result in adverse or negative comments and therefore is issuing it as technical amendments with request for comments. Since the document would make only nonsubstantive word changes, the FAA is unaware of any opposition to these changes. Unless a written adverse or negative comment, or a written notice of intent to submit an adverse or negative comment is received within the comment period, the regulation will become effective on the date specified. After the close of the comment period, the FAA will publish a document in the *Federal Register* indicating that no adverse or negative comments were received and confirming the date on which the final rule will become effective. If the FAA does receive, within the comment period, an adverse or negative comment, or written notice of intent to submit such a comment, a document withdrawing the amendments will be published in the *Federal Register*, and a Notice of Proposed Rulemaking (NPRM) may be published with a new comment period.

Comments Invited

Although this action was not preceded by an NPRM, comments are invited on this rule. Interested persons are invited to comment on this rule by submitting such written data, views, or arguments as they may desire. Comments should identify the Rules Docket number and be submitted in duplicate to the address specified under the caption "ADDRESSES." All communications received on or before the closing date for comments will be considered, and this rule may be amended or withdrawn in light of the comments received. Factual information that supports the commenter's ideas and suggestions is extremely helpful in evaluating the effectiveness of this action and determining whether additional rulemaking action would be needed.

Comments are specifically invited on the overall regulatory, economic, environmental, and energy aspects of the rule that might suggest a need to modify the rule. All comments submitted will be available, both before and after the closing date for comments, in the Rules Docket for examination phone: 703–321–3339) or the Federal Register's electronic bulletin board service (telephone: 202–512–1661).

Internet users may reach the FAA's web page at http://www.faa.gov or the Federal Register's web page at http://www.access.gpo.gov/su_docs for access to recently published rulemaking documents.

Any person may obtain a copy of this document by submitting a request to the FAA, Office of Rulemaking (ARM–1), 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Communications must identify the amendment number or docket number.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), there are no reporting or recordkeeping requirements associated with this document.

Agency Findings

The regulations adopted herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this rule does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

The FAA has determined that this regulation is noncontroversial and unlikely to result in adverse or negative comments. For the reasons discussed in the preamble, I certify that this regulation (1) is not a ''significant regulatory action'' under Executive Order 12866; (2) is not a ''significant rule'' under DOT Regulatory Policies and Procedures (44 FR 11034, February 26, 1979); and (3) if promulgated, will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. A copy of the regulatory evaluation prepared for this action is contained in the Rules Docket. A copy of it may be obtained by contacting the Rules Docket at the location provided under the caption ''ADDRESSES.''

International Trade Impact Statement

The rule will not constitute a barrier to international trade, including the export of U.S. goods and services to foreign countries and the import of foreign goods and services into the United States.

Unfunded Mandates Reform Act Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), codified as 2 U.S.C. §§ 1501–1571, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in expenditures by State, local, and tribal governments, in the aggregate, or by the private sector of $100 million or more (adjusted annually for inflation) in any one year.

This rule does not meet the thresholds of the Act. Therefore, the requirements of Title II of the Act do not apply.

Conclusion

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination and International Trade Impact Analysis, the FAA has determined that this regulation is not significant under Executive Order 12866. In addition, the FAA certifies that this rule will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This regulation is not considered significant under DOT Order 2100.5, Policies and Procedures for Simplification, Analysis, and Review of Regulations.

Ch. 5

§ 27.21 Proof of compliance.

Each requirement of this subpart must be met at each appropriate combination of weight and center of gravity within the range of loading conditions for which certification is requested. This must be shown—

(a) By tests upon a rotorcraft of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(b) By systematic investigation of each required combination of weight and center of gravity if compliance cannot be reasonably inferred from combinations investigated.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.25 Weight limits.

(a) *Maximum weight.* The maximum weight (the highest weight at which compliance with each applicable requirement of this part is shown) must be established so that it is—

(1) Not more than—

(i) The highest weight selected by the applicant;

(ii) The design maximum weight (the highest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The highest weight at which compliance with each applicable flight requirement of this part is shown; and

(2) Not less than the sum of—

(i) The empty weight determined under § 27.29;

(ii) The weight of usable fuel appropriate to the intended operation with full payload;

(iii) The weight of full oil capacity; and

(iv) For each seat, an occupant weight of 170 pounds or any lower weight for which certification is requested.

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of this part is shown) must be established so that it is—

(1) Not more than the sum of—

(i) The empty weight determined under § 27.29; and

(ii) The weight of the minimum crew necessary to operate the rotorcraft, assuming for each crewmember a weight no more than 170 pounds, or any lower weight selected by the applicant, or included in the loading instructions; and

(2) Not less than—

(i) The lowest weight selected by the applicant;

(ii) The design minimum weight (the lowest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The lowest weight at which compliance with each applicable flight requirement of this part is shown.

(c) *Total weight with jettisonable external load.* A total weight for the rotorcraft with jettisonable external load attached that is greater than the maximum weight established under paragraph (a) of this section may be established if structural component approval for external load operations under part 133 of this chapter is requested and the following conditions are met:

(1) The portion of the total weight that is greater than the maximum weight established under paragraph (a) of this section is made up only of the weight of all or part of the jettisonable external load.

(2) Structural components of the rotorcraft are shown to comply with the applicable structural requirements of this part under the increased loads and stresses caused by the weight increase over that established under paragraph (a) of this section.

(3) Operation of the rotorcraft at a total weight greater than the maximum certificated weight established under paragraph (a) of this section is limited by appropriate operating limitations to

gravity must be established for each weight established under § 27.25. Such an extreme may not lie beyond—

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with the applicable flight requirements is shown.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.29 Empty weight and corresponding center of gravity.

(a) The empty weight and corresponding center of gravity must be determined by weighing the rotorcraft without the crew and payload, but with—

(1) Fixed ballast;

(2) Unusable fuel; and

(3) Full operating fluids, including—

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of rotorcraft systems, except water intended for injection in the engines.

(b) The condition of the rotorcraft at the time of determining empty weight must be one that is well defined and can be easily repeated, particularly with respect to the weights of fuel, oil, coolant, and installed equipment.

(Amdt. 27–14, Eff. 3/1/78)

§ 27.31 Removable ballast.

Removable ballast may be used in showing compliance with the flight requirements of this subpart.

§ 27.33 Main rotor speed and pitch limits.

(a) *Main rotor speed limits.* A range of main rotor speeds must be established that—

(1) With power on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate maneuver, and is consistent with the kind of governor or synchronizer used; and

maximum limitations, that main rotor speeds substantially less than the minimum approved main rotor speed will not occur under any sustained flight condition. This must be met by—

(1) Appropriate setting of the main rotor high pitch stop;

(2) Inherent rotorcraft characteristics that make unsafe low main rotor speeds unlikely; or

(3) Adequate means to warn the pilot of unsafe main rotor speeds.

(c) *Normal main rotor low pitch limits (power off).* It must be shown, with power off, that—

(1) The normal main rotor low pitch limit provides sufficient rotor speed, in any autorotative condition, under the most critical combinations of weight and airspeed; and

(2) It is possible to prevent overspeeding of the rotor without exceptional piloting skill.

(d) *Emergency high pitch.* If the main rotor high pitch stop is set to meet paragraph (b)(1) of this section, and if that stop cannot be exceeded inadvertently, additional pitch may be made available for emergency use.

(e) *Main rotor low speed warning for helicopters.* For each single engine helicopter, and each multiengine helicopter that does not have an approved device that automatically increases power on the operating engines when one engine fails, there must be a main rotor low speed warning which meets the following requirements:

(1) The warning must be furnished to the pilot in all flight conditions, including power-on and power-off flights, when the speed of a main rotor approaches a value that can jeopardize safe flight.

(2) The warning may be furnished either through the inherent aerodynamic qualities of the helicopter or by a device.

(3) The warning must be clear and distinct under all conditions, and must be clearly distinguishable from all other warnings. A visual device that requires the attention of the crew within the cockpit is not acceptable by itself.

(4) If a warning device is used, the device must automatically deactivate and reset when the low-speed condition is corrected. If the device

§ 27.45 General.

(a) Unless otherwise prescribed, the performance requirements of this subpart must be met for still air and a standard atmosphere.

(b) The performance must correspond to the engine power available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in paragraphs (d) or (e) of this section, as appropriate.

(c) The available power must correspond to engine power, not exceeding the approved power, less—

(1) Installation losses; and

(2) The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(d) For reciprocating engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of 80 percent in a standard atmosphere.

(e) For turbine engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of—

(1) 80 percent, at and below standard temperature; and

(2) 34 percent, at and above standard temperature plus 50 degrees F. Between these two temperatures, the relevant humidity must vary linearly.

(f) For turbine-engine-powered rotorcraft, a means must be provided to permit the pilot to determine prior to takeoff that each engine is capable of developing the power necessary to achieve the applicable rotorcraft performance prescribed in this subpart.

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.51 Takeoff.

(a) The takeoff, with takeoff power and r.p.m., and with the extreme forward center of gravity—

craft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight at sea level) to each lesser weight selected by the applicant for each altitude covered by paragraph (b)(1) of this section.

§ 27.65 Climb: All engines operating.

(a) For rotorcraft other than helicopters—

(1) The steady rate of climb, at V_Y, must be determined—

(i) With maximum continuous power on each engine;

(ii) With the landing gear retracted; and

(iii) For the weights, altitudes, and temperatures for which certification is requested; and

(2) The climb gradient, at the rate of climb determined in accordance with paragraph (a)(1) of this section, must be either—

(i) At least 1:10 if the horizontal distance required to take off and climb over a 50-foot obstacle is determined for each weight, altitude, and temperature within the range for which certification is requested; or

(ii) At least 1:6 under standard sea level conditions.

(b) Each helicopter must meet the following requirements:

(1) V_Y must be determined—

(i) For standard sea level conditions;

(ii) At maximum weight; and

(iii) With maximum continuous power on each engine.

(2) If at any altitude within the range for which certification is requested, V_{NE} is less than V_Y the steady rate of climb must be determined—

(i) At the climb speed selected by the applicant at or below V_{NE};

(ii) Within the range from 2,000 feet below the altitude at which V_{NE} is equal to V_Y up to the maximum altitude for which certification is requested;

(iii) For the weights and temperature that correspond to the altitude range set forth in climb (or descent), at V_Y (or at the speed for minimum rate of descent), must be determined with—

(a) Maximum weight;

(b) The critical engine inoperative and the remaining engines at either—

(1) Maximum continuous power and, for helicopters for which certification for the use of 30-minute OEI power is requested, at 30-minute OEI power; or

(2) Continuous OEI power for helicopters for which certification for the use of continuous OEI power is requested.

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–23, Eff. 10/3/88)

§ 27.71 Glide performance.

For single-engine helicopters and multi-engine helicopters that do not meet the Category A engine isolation requirements of part 29 of this chapter, the minimum rate of descent airspeed and the best angle-of-glide airspeed must be determined in autorotation at—

(a) Maximum weight; and

(b) Rotor speed(s) selected by the applicant.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.73 Performance at minimum operating speed.

(a) For helicopters—

(1) The hovering ceiling must be determined over the ranges of weight, altitude, and temperature for which certification is requested, with—

(i) Takeoff power;

(ii) The landing gear extended; and

(iii) The helicopter in ground effect at a height consistent with normal takeoff procedures; and

(2) The hovering ceiling determined under paragraph (a)(1) of this section must be at least—

(i) For reciprocating engine powered helicopters, 4,000 feet at maximum weight with a standard atmosphere; or

(2) The landing gear extended.

§ 27.75 Landing.

(a) The rotorcraft must be able to be landed with no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and without exceptional piloting skill or exceptionally favorable conditions, with—

(1) Approach or glide speeds appropriate to the type of rotorcraft and selected by the applicant;

(2) The approach and landing made with—

(i) Power off, for single-engine rotorcraft; and

(ii) For multiengine rotorcraft, one engine inoperative and with each operating engine within approved operating limitations; and

(3) The approach and landing entered from steady autorotation.

(b) Multiengine rotorcraft must be able to be landed safely after complete power failure under normal operating conditions.

(Amdt. 27–14, Eff. 3/1/78)

§ 27.79 Limiting height-speed envelope.

(a) If there is any combination of height and forward speed (including hover) under which a safe landing cannot be made under the applicable power failure condition in paragraph (b) of this section, a limiting height-speed envelope must be established (including all pertinent information) for that condition, throughout the ranges of—

(1) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight (at sea level) to the lesser weight selected by the applicant for each altitude covered by paragraph (a)(1) of this section. For helicopters, the weight at altitudes above sea level may not be less than the maximum weight or the highest weight allowing hovering out of ground effect, whichever is less.

(b) The applicable power failure conditions are—

to the type.

(Amdt. 27–16, Eff. 12/1/78); (Amdt. 27–21, Eff. 12/6/84)

FLIGHT CHARACTERISTICS

§ 27.141 General.

The rotorcraft must—

(a) Except as specifically required in the applicable section, meet the flight characteristics requirements of this subpart—

(1) At the altitudes and temperatures expected in operation;

(2) Under any critical loading condition within the range of weights and centers of gravity for which certification is requested;

(3) For power-on operations, under any condition of speed, power, and rotor r.p.m. for which certification is requested; and

(4) For power-off operations, under any condition of speed and rotor r.p.m. for which certification is requested that is attainable with the controls rigged in accordance with the approved rigging instructions and tolerances;

(b) Be able to maintain any required flight condition and make a smooth transition from any flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the limit load factor under any operating condition probable for the type, including—

(1) Sudden failure of one engine, for multiengine rotorcraft meeting transport category A engine isolation requirements of part 29 of this chapter; and

(2) Sudden, complete power failure for other rotorcraft;

(3) Sudden, complete control system failures specified in § 27.695 of this part; and

(c) Have any additional characteristic required for night or instrument operation, if certification for those kinds of operation is requested. Require-

maneuverable—

(1) During steady flight; and

(2) During any maneuver appropriate to the type including—

(i) Takeoff;

(ii) Climb;

(iii) Level flight;

(iv) Turning flight;

(v) Glide;

(vi) Landing (power on and power off); and

(vii) Recovery to power-on flight from a balked autorotative approach.

(b) The margin of cyclic control must allow satisfactory roll and pitch control at V_{NE} with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Critical rotor r.p.m.; and

(4) Power off (except for helicopters demonstrating compliance with paragraph (e) of this section) and power on.

(c) A wind velocity of not less than 17 knots must be established in which the rotorcraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind takeoffs, sideward flight, and rearward flight), with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Critical rotor r.p.m.; and

(4) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft or 7,000 feet, whichever is less.

(d) The rotorcraft, after (1) failure of one engine in the case of multiengine rotorcraft that meet transport category A engine isolation requirements, or (2) complete engine failure in the case of other rotorcraft, must be controllable over the range of speeds and altitudes for which certification is requested when such power failure occurs with maximum continuous power and critical weight. No corrective action time delay for any condition following power failure may be less than—

(i) For the cruise condition, one second, or normal pilot reaction time (whichever is greater); and after the last operating engine is made inoperative at power-on V_{NE}.

(2) At a speed of 1.1 V_{NE} (power-off), the margin of cyclic control must allow satisfactory roll and pitch control with power off.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.151 Flight controls.

(a) Longitudinal, lateral, directional, and collective controls may not exhibit excessive breakout force, friction, or preload.

(b) Control system forces and free play may not inhibit a smooth, direct rotorcraft response to control system input.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.161 Trim control.

The trim control—

(a) Must trim any steady longitudinal, lateral, and collective control forces to zero in level flight at any appropriate speed; and

(b) May not introduce any undesirable discontinuities in control force gradients.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.171 Stability: General.

The rotorcraft must be able to be flown, without undue pilot fatigue or strain, in any normal maneuver for a period of time as long as that expected in normal operation. At least three landings and takeoffs must be made during this demonstration.

§ 27.173 Static longitudinal stability.

(a) The longitudinal control must be designed so that a rearward movement of the control is necessary to obtain a speed less than the trim speed, and a forward movement of the control is necessary to obtain a speed more than the trim speed.

(b) With the throttle and collective pitch held constant during the maneuvers specified in § 27.175(a) through (c), the slope of the control position versus speed curve must be positive

§ 27.175 Demonstration of static longitudinal stability.

(a) *Climb.* Static longitudinal stability must be shown in the climb condition at speeds from 0.85 V_Y to 1.2 V_Y, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Maximum continuous power;

(4) The landing gear retracted; and

(5) The rotorcraft trimmed at V_Y.

(b) *Cruise.* Static longitudinal stability must be shown in the cruise condition at speeds from 0.7 V_H or 0.7 VNE, whichever is less, to 1.1 V_H or 1.1 V_{NE}, whichever is less, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power for level flight at 0.9 V_H or 0.9 V_{NE}, whichever is less;

(4) The landing gear retracted; and

(5) [The rotorcraft trimmed at 0.9 V_H or 0.9 V_{NE}, whichever is less.]

(c) *Autorotation.* Static longitudinal stability must be shown in autorotation at airspeeds from 0.5 times the speed for minimum rate of descent to V_{NE}, or to 1.1 V_{NE} (power-off) if V_{NE} (power-off) is established under § 27.1505(c), and with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power off;

(4) The landing gear—

(i) Retracted; and

(ii) Extended; and

(5) The rotorcraft trimmed at appropriate speeds found necessary by the Administrator to demonstrate stability throughout the prescribed speed range.

(d) *Hovering.* For helicopters, the longitudinal cyclic control must operate with the sense and direction of motion prescribed in § 27.173 between the maximum approved rearward speed and a forward speed of 17 knots with—

(1) Critical weight;

§ 27.177 Static directional stability.

Static directional stability must be positive with throttle and collective controls held constant at the trim conditions specified in § 27.175(a) and (b). This must be shown by steadily increasing directional control deflection for sideslip angles up to ±10° from trim. Sufficient cues must accompany sideslip to alert the pilot when approaching sideslip limits.

(Amdt. 27–21, Eff. 12/6/84)

GROUND AND WATER HANDLING CHARACTERISTICS

§ 27.231 General.

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom

§ 27.239 Spray characteristics.

If certification for water operation is requested, no spray characteristics during taxiing, takeoff, or landing may obscure the vision of the pilot or damage the rotors, propellers, or other parts of the rotorcraft.

§ 27.241 Ground resonance.

The rotorcraft may have no dangerous tendency to oscillate on the ground with the rotor turning.

MISCELLANEOUS FLIGHT REQUIREMENTS

§ 27.251 Vibration.

Each part of the rotorcraft must be free from excessive vibration under each appropriate speed and power condition.

General

§ 27.301 Loads.

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

§ 27.303 Factor of safety.

Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.

§ 27.305 Strength and deformation.

(a) The structure must be able to support limit loads without detrimental or permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure. This must be shown by—

(1) Applying ultimate loads to the structure in a static test for at least three seconds; or

(2) Dynamic tests simulating actual load application.

§ 27.307 Proof of structure.

(a) [Compliance with the strength and deformation requirements of this subpart must be shown for each critical loading condition accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made.]

(b) Proof of compliance with the strength requirements of this subpart must include—

(1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;

(2) Limit load tests of the control system, including control surfaces;

(3) Operation tests of the control system;

(4) Flight stress measurement tests;

(5) Landing gear drop tests; and

(6) Any additional tests required for new or unusual design features.

(Amdt. 27–3, Eff. 10/17/68); [(Amdt. 27–26, Eff. 4/5/90)]

§ 27.309 Design limitations.

The following values and limitations must be established to show compliance with the structural requirements of this subpart:

(a) The design maximum weight.

(b) The main rotor r.p.m. ranges, power on and power off.

(c) The maximum forward speeds for each main rotor r.p.m. within the ranges determined under paragraph (b) of this section.

(d) The maximum rearward and sideward flight speeds.

(e) The center of gravity limits corresponding to the limitations determined under paragraphs (b), (c), and (d) of this section.

(f) The rotational speed ratios between each powerplant and each connected rotating component.

(g) The positive and negative limit maneuvering load factors.

FLIGHT LOADS

§ 27.321 General.

(a) The flight load factor must be assumed to act normal to the longitudinal axis of the rotorcraft, and to be equal in magnitude and opposite in direction to the rotorcraft inertia load factor at the center of gravity.

§ 27.337 Limit maneuvering load factor.

[The rotorcraft must be designed for—

[(a) A limit maneuvering load factor ranging from a positive limit of 3.5 to a negative limit of − 1.0; or

[(b) Any positive limit maneuvering load factor not less than 2.0 and any negative limit maneuvering load factor of not less than − 0.5 for which—

[(1) The probability of being exceeded is shown by analysis and flight tests to be extremely remote; and

[(2) The selected values are appropriate to each weight condition between the design maximum and design minimum weights.]

[(Amdt. 27–26, Eff. 4/5/90)]

§ 27.339 Resultant limit maneuvering loads.

The loads resulting from the application of limit maneuvering load factors are assumed to act at the center of each rotor hub and at each auxiliary lifting surface, and to act in directions, and with distributions of load among the rotors and auxiliary lifting surfaces, so as to represent each critical maneuvering condition, including power-on and power-off flight with the maximum design rotor tip speed ratio. The rotor tip speed ratio is the ratio of the rotorcraft flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades, and is expressed as follows:

$$\mu = \frac{V \cos a}{\Omega R}$$

Where—

V = The airspeed along flight path (f.p.s.);

a = The angle between the projection, in the plane of symmetry, of the axis of no feathering and a line perpendicular to the flight path (radians, positive when the axis is pointing aft);

omega = The angular velocity of rotor (radians per second); and

R = The rotor radius (ft).

(Amdt. 27–11, Eff. 2/1/77)

resulting from the maneuvers specified in paragraphs (b) and (c) of this section with—

(1) Unbalanced aerodynamic moments about the center of gravity which the aircraft reacts to in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces; and

(2) Maximum main rotor speed.

(b) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from zero up to 0.6 V_{NE}—

(1) Displace the cockpit directional control suddenly to the maximum deflection limited by the control stops or by the [maximum pilot force specified in § 27.397(a);]

(2) Attain a resulting sideslip angle or 90°, whichever is less; and

(3) Return the directional control suddenly to neutral.

(c) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from 0.6 V_{NE} up to V_{NE} or V_H, whichever is less—

(1) Displace the cockpit directional control suddenly to the maximum deflection limited by, the control stops or by the [maximum pilot force specified in § 27.397(a);]

(2) Attain a resulting sideslip angle or 15°, whichever is less, at the lesser speed of V_{NE} or V_H;

(3) Vary the sideslip angles of paragraphs (b)(2) and (c)(2) of this section directly with speed; and

(4) Return the directional control suddenly to neutral.

(Amdt. 27–26, Eff. 4/5/90); [(Amdt. 27–34, Eff. 11/28/97)]

§ 27.361 Engine torque.

(a) For turbine engines, the limit torque may not be less than the highest of—

(1) The mean torque for maximum continuous power multiplied by 1.25;

(2) The torque required by § 27.923;

(2) Two, three, and four, for engines with four, three, and two cylinders, respectively.

(Amdt. 27–23, Eff. 10/3/88)

CONTROL SURFACE AND SYSTEM LOADS

§ 27.391 General.

Each auxiliary rotor, each fixed or movable stabilizing or control surface, and each system operating any flight control must meet the requirements of [§§ 27.395, 27.397, 27.399, 27.411, and 27.427.]

(Amdt. 27–26, Eff. 4/5/90); [(Amdt. 27–34, Eff. 11/28/97)]

§ 27.395 Control system.

(a) The part of each control system from the pilot's controls to the control stops must be designed to withstand pilot forces of not less than—

(1) The forces specified in § 27.397; or

(2) If the system prevents the pilot from applying the limit pilot forces to the system, the maximum forces that the system allows the pilot to apply, but not less than 0.60 times the forces specified in § 27.397.

(b) Each primary control system, including its supporting structure, must be designed as follows:

(1) The system must withstand loads resulting from the limit pilot forces prescribed in § 27.397.

(2) Notwithstanding paragraph (b)(3) of this section, when power-operated actuator controls or power boost controls are used, the system must also withstand the loads resulting from the force output of each normally energized power device, including any single power boost or actuator system failure.

(3) If the system design or the normal operating loads are such that a part of the system cannot react to the limit pilot forces prescribed in § 27.397, that part of the system must be designed to withstand the maximum loads that can be obtained in normal operation. The minimum design loads must, in any case, provide sufficient strength, rigidity, and reliability, considering wear, inertia, backlash, and the pilot forces specified in § 27.397, without yielding.

(Amdt. 27–26, Eff. 4/5/90)

§ 27.397 Limit pilot forces and torques.

(a) Except as provided in paragraph (b) of this section, the limit pilot forces are as follows:

(1) For foot controls, 130 pounds.

(2) For stick controls, 100 pounds fore and aft, and 67 pounds laterally.

(b) For flap, tab, stabilizer, rotor brake, and landing gear operating controls, the following apply (R=radius in inches):

(1) Crank, wheel, and level controls, [1+R] 3/×50 pounds, but not less than 50 pounds nor more than 100 pounds for hand operated controls or 130 pounds for foot operated controls, applied at any angle within 20 degrees of the plane of motion of the control.

(2) Twist controls, 80R pounds.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.399 Dual control system.

Each dual primary flight control system must be designed to withstand the loads that result when pilot forces of 0.75 times those obtained under § 27.395 are applied—

(a) In opposition; and

(b) In the same direction.

§ 27.401 [Removed]

§ 27.403 [Removed]

§ 27.411 Ground clearance: Tail rotor guard.

(a) It must be impossible for the tail rotor to contact the landing surface during a normal landing.

(b) If a tail rotor guard is required to show compliance with paragraph (a) of this section—

(1) Suitable design loads must be established for the guard; and

(2) The guard and its supporting structure must be designed to withstand those loads.

of this section, in the absence of more rational data, both of the following must be met:

(1) One hundred percent of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry, and no loading acts on the other side.

(2) Fifty percent of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry but in opposite directions.

(c) For empennage arrangements where the horizontal tail surfaces are supported by the vertical tail surfaces, the vertical tail surfaces and supporting structure must be designed for the combined vertical horizontal surface loads resulting from each prescribed flight condition, considered separately. The flight conditions must be selected so the maximum design loads are obtained on each surface. In the absence of more rational data, the unsymmetrical horizontal tail surface loading distributions described in this section must be assumed.

(Amdt. 27–26, Eff. 4/5/90); (Amdt. 27–27, Eff. 10/22/90)

GROUND LOADS

§ 27.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) The limit ground loads obtained in the landing conditions in this part must be considered to be external loads that would occur in the rotorcraft structure if it were acting as a rigid body; and

(2) In each specified landing condition, the external loads must be placed in equilibrium with linear and angular inertia loads in a rational or conservative manner.

(b) *Critical centers of gravity.* The critical centers of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element.

(b) Unless otherwise prescribed, for each specified landing condition, the rotorcraft must be designed for a limit load factor of not less than the limit inertia load factor substantiated under § 27.725.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.475 Tires and shock absorbers.

Unless otherwise prescribed, for each specified landing condition, the tires must be assumed to be in their static position and the shock absorbers to be in their most critical position.

§ 27.477 Landing gear arrangement.

Sections 27.235, 27.479 through 27.485, and 27.493 apply to landing gear with two wheels aft, and one or more wheels forward, of the center of gravity.

§ 27.479 Level landing conditions.

(a) *Attitudes.* Under each of the loading conditions prescribed in paragraph (b) of this section, the rotorcraft is assumed to be in each of the following level landing attitudes:

(1) An attitude in which all wheels contact the ground simultaneously.

(2) An attitude in which the aft wheels contact the ground with the forward wheels just clear of the ground.

(b) *Loading conditions.* The rotorcraft must be designed for the following landing loading conditions:

(1) Vertical loads applied under § 27.471.

(2) The loads resulting from a combination of the loads applied under paragraph (b)(1) of this section with drag loads at each wheel of not less than 25 percent of the vertical load at that wheel.

(3) If there are two wheels forward, a distribution of the loads applied to those wheels under paragraphs (b)(1) and (2) of this section in a ratio of 40:60.

(c) *Pitching moments.* Pitching moments are assumed to be resisted by—

mum nose-up attitude allowing ground clearance by each part of the rotorcraft.

(b) in this attitude, ground loads are assumed to act perpendicular to the ground.

§ 27.483 One-wheel landing conditions.

For the one-wheel landing condition, the rotorcraft is assumed to be in the level attitude and to contact the ground on one aft wheel. In this attitude—

(a) The vertical load must be the same as that obtained on that side under § 27.479(b)(1); and

(b) The unbalanced external loads must be reacted by rotorcraft inertia.

§ 27.485 Lateral drift landing conditions.

(a) The rotorcraft is assumed to be in the level landing attitude, with—

(1) Side loads combined with one-half of the maximum ground reactions obtained in the level landing conditions of § 27.479(b)(1); and

(2) The loads obtained under paragraph (a)(1) of this section applied—

(i) At the ground contact point; or

(ii) For full-swiveling gear, at the center of the axle.

(b) The rotorcraft must be designed to withstand, at ground contact—

(1) When only the aft wheels contact the ground, side loads of 0.8 times the vertical reaction acting inward on one side, and 0.6 times the vertical reaction acting outward on the other side, all combined with the vertical loads specified in paragraph (a) of this section; and

(2) When all wheels contact the ground simultaneously—

(i) For the aft wheels, the side loads specified in paragraph (b)(1) of this section; and

(ii) For the forward wheels, a side load of 0.8 times the vertical reaction combined with the vertical load specified in paragraph (a) of this section.

§ 27.479(a)(2); and

(b) The structure must be designed to withstand, at the ground contact point of each wheel with brakes, a drag load at least the lesser of—

(1) The vertical load multiplied by a coefficient of friction of 0.8; and

(2) The maximum value based on limiting brake torque.

§ 27.497 Ground loading conditions: Landing gear with tail wheels.

(a) *General.* Rotorcraft with landing gear with two wheels forward, and one wheel aft, of the center of gravity must be designed for loading conditions as prescribed in this section.

(b) *Level landing attitude with only the forward wheels contacting the ground.* In this attitude—

(1) The vertical loads must be applied under §§ 27.471 through 27.475;

(2) The vertical load at each axle must be combined with a drag load at that axle of not less than 25 percent of that vertical load; and

(3) Unbalanced pitching moments are assumed to be resisted by angular inertia forces.

(c) *Level landing attitude with all wheels contacting the ground simultaneously.* In this attitude, the rotorcraft must be designed for landing loading conditions as prescribed in paragraph (b) of this section.

(d) *Maximum nose-up attitude with only the rear wheel contacting the ground.* The attitude for this condition must be the maximum nose-up attitude expected in normal operation, including autorotative landings. In this attitude—

(1) The appropriate ground loads specified in paragraphs (b)(1) and (2) of this section must be determined and applied, using a rational method to account for the moment arm between the rear wheel-ground reaction and the rotorcraft center of gravity; or

(2) The probability of landing with initial contact on the rear wheel must be shown to be extremely remote.

(e) *Level landing attitude with only one forward wheel contacting the ground.* In this attitude, the ground reactions obtained for that wheel under paragraphs (b) and (c) of this section. In this condition, the side loads must be—

(i) For the forward wheels, 0.8 times the vertical reaction (on one side) acting inward, and 0.6 times the vertical reaction (on the other side) acting outward; and

(ii) For the rear wheel, 0.8 times the vertical reaction.

(2) The loads specified in paragraph (f)(1) of this section must be applied—

(i) At the ground contact point with the wheel in the trailing position (for non-full swiveling landing gear with a lock, steering device, or shimmy damper to keep the wheel in the trailing position); or

(ii) At the center of the axle (for full swiveling landing gear without a lock, steering device, or shimmy damper).

(g) *Braked roll conditions in the level landing attitude.* In the attitudes specified in paragraphs (b) and (c) of this section, and with the shock absorbers in their static positions, the rotorcraft must be designed for braked roll loads as follows:

(1) The limit vertical load must be based on a limit vertical load factor of not less than—

(i) 1.0, for the attitude specified in paragraph (b) of this section; and

(ii) 1.33, for the attitude specified in paragraph (c) of this section.

(2) For each wheel with brakes, a drag load must be applied, at the ground contact point, of not less than the lesser of—

(i) 0.8 times the vertical load; and

(ii) The maximum based on limiting brake torque.

(h) *Rear wheel turning loads in the static ground attitude.* In the static ground attitude, and with the shock absorbers and tires in their static positions, the rotorcraft must be designed for rear wheel turning loads as follows:

(1) A vertical ground reaction equal to the static load on the rear wheel must be combined with an equal sideload.

is a lock, steering device or shimmy damper (the rear wheel being assumed to be in the trailing position).

(i) *Taxiing condition.* The rotorcraft and its landing gear must be designed for loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

§ 27.501 Ground loading conditions: Landing gear with skids.

(a) *General.* Rotorcraft with landing gear with skids must be designed for the loading conditions specified in this section. In showing compliance with this section, the following apply:

(1) The design maximum weight, center of gravity, and load factor must be determined under §§ 27.471 through 27.475.

(2) Structural yielding of elastic spring members under limit loads is acceptable.

(3) Design ultimate loads for elastic spring members need not exceed those obtained in a drop test of the gear with—

(i) A drop height of 1.5 times that specified in § 27.725; and

(ii) An assumed rotor lift of not more than 1.5 times that used in the limit drop tests prescribed in § 27.725.

(4) Compliance with paragraphs (b) through (e) of this section must be shown with—

(i) The gear in its most critically deflected position for the landing condition being considered; and

(ii) The ground reactions rationally distributed along the bottom of the skid tube.

(b) *Vertical reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the vertical reactions must be applied as prescribed in paragraph (a) of this section.

(c) *Drag reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

the ground along the bottom of both skids, the following apply:

(1) The vertical ground reaction must be—

(i) Equal to the vertical loads obtained in the condition specified in paragraph (b) of this section; and

(ii) Divided equally among the skids.

(2) The vertical ground reactions must be combined with a horizontal sideload of 25 percent of their value.

(3) [The total sideload must be applied equally between the skids and along the length of the skids.]

(4) The unbalanced moments are assumed to be resisted by angular inertia.

(5) The skid gear must be investigated for—

(i) Inward acting sideloads; and

(ii) Outward acting sideloads.

(e) *One-skid landing loads in the level attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of one skid only, the following apply:

(1) The vertical load on the ground contact side must be the same as that obtained on that side in the condition specified in paragraph (b) of this section.

(2) The unbalanced moments are assumed to be resisted by angular inertia.

(f) *Special conditions.* In addition to the conditions specified in paragraphs (b) and (c) of this section, the rotorcraft must be designed for the following ground reactions:

(1) A ground reaction load acting up and aft at an angle of 45° to the longitudinal axis of the rotorcraft. This load must be—

(i) Equal to 1.33 times the maximum weight;

(ii) Distributed symmetrically among the skids;

(iii) Concentrated at the forward end of the straight part of the skid tube; and

(iv) Applied only to the forward end of the skid tube and its attachment to the rotorcraft.

(2) With the rotorcraft in the level landing attitude, a vertical ground reaction load equal to

(Amdt. 27-2, Eff. 2/25/68); [(Amdt. 27-26, Eff. 4/5/90)]

§ 27.505 Ski landing conditions.

If certification for ski operation is requested, the rotorcraft, with skis, must be designed to withstand the following loading conditions (where *P* is the maximum static weight on each ski with the rotorcraft at design maximum weight, and *n* is the limit load factor determined under § 27.473(b).

(a) Up-load conditions in which—

(1) A vertical load of *Pn* and a horizontal load of *Pn*/4 are simultaneously applied at the pedestal bearings; and

(2) A vertical load of 1.33 *P* is applied at the pedestal bearings.

(b) A side-load condition in which a side load of 0.35 *Pn* is applied at the pedestal bearings in a horizontal plane perpendicular to the centerline of the rotorcraft.

(c) A torque-load condition in which a torque load of 1.33 *P* (in foot pounds) is applied to the ski about the vertical axis through the centerline of the pedestal bearings.

WATER LOADS

§ 27.521 Float landing conditions.

If certification for float operation is requested, the rotorcraft, with floats, must be designed to withstand the following loading conditions (where the limit load factor is determined under § 27.473(b) or assumed to be equal to that determined for wheel landing gear):

(a) Up-load conditions in which—

(1) A load is applied so that, with the rotorcraft in the static level attitude, the resultant water reaction passes vertically through the center of gravity; and

(2) The vertical load prescribed in paragraph (a)(1) of this section is applied simultaneously with an aft component of 0.25 times the vertical component.

(b) A side-load condition in which—

MAIN COMPONENT REQUIREMENTS

§ 27.547 Main rotor structure.

(a) Each main rotor assembly (including rotor hubs and blades) must be designed as prescribed in this section.

(b) [Reserved]

(c) The main rotor structure must be designed to withstand the following loads prescribed in §§ 27.337 through 27.341:

(1) Critical flight loads.

(2) Limit loads occurring under normal conditions of autorotation. For this condition, the rotor r.p.m. must be selected to include the effects of altitude.

(d) The main rotor structure must be designed to withstand loads simulating—

(1) For the rotor blades, hubs, and flapping hinges, the impact force of each blade against its stop during ground operation; and

(2) Any other critical condition expected in normal operation.

(e) The main rotor structure must be designed to withstand the limit torque at any rotational speed, including zero. In addition:

(1) The limit torque need not be greater than the torque defined by a torque limiting device (where provided), and may not be less than the greater of—

(i) The maximum torque likely to be transmitted to the rotor structure in either direction; and

(ii) The limit engine torque specified in § 27.361.

(2) The limit torque must be distributed to the rotor blades in a rational manner.

(Amdt. 27–3, Eff. 10/17/68)

§ 27.549 Fuselage, landing gear, and rotor pylon structures.

(a) Each fuselage, landing gear, and rotor pylon structure must be designed as prescribed in this section. Resultant rotor forces may be represented

(3) The loads prescribed in § 27.547(d)(2) and (e).

(c) Auxiliary rotor thrust, and the balancing air and inertia loads occurring under accelerated flight conditions, must be considered.

(d) Each engine mount and adjacent fuselage structure must be designed to withstand the loads occurring under accelerated flight and landing conditions, including engine torque.

(Amdt. 27–3, Eff. 10/17/68)

EMERGENCY LANDING CONDITIONS

§ 27.561 General.

(a)The rotorcraft, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this section to protect the occupants under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when—

(1) Proper use is made of seats, belts, and other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) Each occupant and each item of mass inside the cabin that could injure an occupant is restrained when subjected to the following ultimate inertial load factors relative to the surrounding structure:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g, after the intended displacement of the seat device.

[(v) Rearward—1.5g]

(c) The supporting structure must be designed to restrain, under any ultimate inertial load up to those specified in this paragraph, any item of mass above and/or behind the crew and passenger compartment that could injure an occupant if it came loose in an emergency landing. Items of mass to be considered include, but are not limited to, rotors, transmissions, and engines. The items of fuel tanks below the passenger floor level must be designed to resist the following ultimate inertial factors and loads and to protect the fuel tanks from rupture when those loads are applied to that area:

(i) Upward—1.5g.

(ii) Forward—4.0g.

(iii) Sideward—2.0g.

(iv) Downward—4.0g.

(Amdt. 27–3, Eff. 10/17/68); (Amdt. 27–25, Eff. 12/13/89); (Amdt. 27–30, Eff. 11/2/94); ⁅(Amdt. 27–32, Eff. 6/11/96)⁆

⁅27.562 Emergency landing dynamic conditions.⁆

⁅(a) The rotorcraft, although it may be damaged in an emergency crash landing, must be designed to reasonably protect each occupant when—

⁅(1) The occupant properly uses the seats, safety belts, and shoulder harnesses provided in the design; and

⁅(2) The occupant is exposed to the loads resulting from the conditions prescribed in this section.

⁅(b) Each seat type design or other seating device approved for crew or passenger occupancy during takeoff and landing must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat in accordance with the following criteria. The tests must be conducted with an occupant, simulated by a 170-pound anthropomorphic test dummy (ATD), as defined by 49 CFR 572, subpart B, or its equivalent, sitting in the normal upright position.

⁅(1) A change in downward velocity of not less than 30 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is canted upward 60° with respect to the impact velocity vector, and the rotorcraft's lateral axis is perpendicular to a vertical plane containing the impact velocity vector and the rotorcraft's longitudinal axis. Peak floor deceleration must occur in not more than 0.031 seconds after impact and must reach a minimum of 30g's.

impact velocity vector, and the rotorcraft's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. Peak floor deceleration must occur in not more than 0.071 seconds after impact and must reach a minimum of 18.4g's.

⁅(3) When floor rails or floor or sidewall attachment devices are used to attach the seating devices to the airframe structure for the conditions of this section, the rails or devices must be misaligned with respect to each other by at least 10° vertically (i.e., pitch out of parallel, and by at least a 10° lateral roll, with the directions optional, to account for possible floor warp.

⁅(c) Compliance with the following must be shown:

⁅(1) The seating device system must remain intact although it may experience separation intended as part of its design.

⁅(2) The attachment between the seating device and the airframe structure must remain intact, although the structure may have exceeded its limit load.

⁅(3) The ATD's shoulder harness strap or straps must remain on or in the immediate vicinity of the ATD's shoulder during the impact.

⁅(4) The safety belt must remain on the ATD's pelvis during the impact.

⁅(5) The ATD's head either does not contact any portion, of the crew or passenger compartment, or if contact is made, the head impact does not exceed a head injury criteria (HIC) of 1,000 as determined by this equation.

$$HIC = (t_2 - t_1)\left[\frac{1}{(t_2 - t_1)}\int_{t_1}^{t_2} a(t)dt\right]^{2.5}$$

Where: a(t) is the resultant acceleration at the center of gravity of the head form expressed as a multiple of g (the acceleration of gravity) and $t_2 - t_1$ is the time duration, in seconds, of major head impact, not to exceed 0.05 seconds.

⁅(6) Loads in individual upper torso harness straps must not exceed 1,750 pounds. If dual straps are used for retaining the upper torso, the

[(Amdt. 27–25, Eff. 12/13/89)]

§ 27.563 Structural ditching provisions.

[If certification with ditching provisions is requested, structural strength for ditching must meet the requirements of this section and § 27.801(e).

[(a) *Forward speed landing conditions.* The rotorcraft must initially contact the most critical wave for reasonably probable water conditions at forward velocities from zero up to 30 knots in likely pitch, roll, and yaw attitudes. The rotorcraft limit vertical descent velocity may not be less than 5 feet per second relative to the mean water surface. Rotor lift may be used to act through the center of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight. A maximum forward velocity of less than 30 knots may be used in design if it can be demonstrated that the forward velocity selected would not be exceeded in a normal one-engine-out touchdown.

[(b) *Auxiliary or emergency float conditions.*

[(1) *Floats fixed or deployed before initial water contact.* In addition to the landing loads in paragraph (a) of this section, each auxiliary or emergency float, of its support and attaching structure in the airframe or fuselage, must be designed for the load developed by a fully immersed float unless it can be shown that full immersion is unlikely. If full immersion is unlikely, the highest likely float buoyancy load must be applied. The highest likely buoyancy load must include consideration of a partially immersed float creating restoring moments to compensate the upsetting moments caused by side wind, unsymmetrical rotorcraft loading, water wave action, rotorcraft inertia, and probable structural damage and leakage considered under § 27.801(d). Maximum roll and pitch angles determined from compliance with § 27.801(d) may be used, if significant, to determine the extent of immersion of each float. If the floats are deployed in flight, appropriate air loads derived from the flight limitations with the floats deployed shall be used in substantiation of the using a relative limit speed of 20 knots between the rotorcraft and the water. The vertical load may not be less than the highest likely buoyancy load determined under paragraph (b)(1) of this section.]

(Amdt. 27–11, Eff. 2/1/77); [(Amdt. 27–26, Eff. 4/5/90)]

FATIGUE EVALUATION

§ 27.571 Fatigue evaluation of flight structure.

(a) [*General.* Each portion of the flight structure (the flight structure includes rotors, rotor drive systems between the engines and the rotor hubs, controls, fuselage, landing gear, and their related primary attachments), the failure of which could be catastrophic, must be identified and must be evaluated under paragraph (b), (c), (d) or (e) of this section. The following apply to each fatigue evaluation:]

(1) The procedure for the evaluation must be approved.

(2) The locations of probable failure must be determined.

(3) Inflight measurement must be included in determining the following:

(i) Loads or stresses in all critical conditions throughout the range of limitations in § 27.309, except that maneuvering load factors need not exceed the maximum values expected in operation.

(ii) The effect of altitude upon these loads or stresses.

(4) [The loading spectra must be as severe as those expected in operation including, but not limited to, external cargo operations, if applicable, and ground-air-ground cycles. The loading spectra must be based on loads or stresses determined under paragraph (a)(3) of this section.]

(b) *Fatigue tolerance evaluation.* It must be shown that the fatigue tolerance of the structure ensures that the probability of catastrophic fatigue failure is extremely remote without establishing

(1) It must be shown that all partial failures will become readily detectable under inspection procedures furnished under section A27.4 of appendix A.

(2) The interval between the time when any partial failure becomes readily detectable under paragraph (d)(1) of this section, and the time when any such failure is expected to reduce the remaining strength of the structure to limit or maximum attainable loads (whichever is less), must be determined.

evaluations. A component may be evaluated under a combination of paragraphs (c) and (d) of this section. For such component it must be shown that the probability of catastrophic failure is extremely remote with an approved combination of replacement time, inspection intervals, and related procedures furnished under section A27.4 of appendix A.

(Amdt. 27–3, Eff. 10/17/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–18, Eff. 10/14/80); [(Amdt. 27–26, Eff. 4/5/90)]

§ 27.601 Design.

(a) The rotorcraft may have no design features or details that experience has shown to be hazardous or unreliable.

(b) The suitability of each questionable design detail and part must be established by tests.

§ 27.603 Materials.

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must—

(a) Be established on the basis of experience or tests:

(b) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–16, Eff. 12/1/78)

§ 27.605 Fabrication methods.

(a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed according to an approved process specification.

(b) Each new aircraft fabrication method must be substantiated by a test program.

(Amdt. 27–16, Eff. 12/1/78)

§ 27.607 Fasteners.

(a) Each removable bolt, screw, nut, pin, or other fastener whose loss could jeopardize the safe operation of the rotorcraft must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

bolt subject to rotation in operation unless a nonfriction locking device is used in addition to the self-locking device.

(Amdt. 27–4, Eff. 10/27/68)

§ 27.609 Protection of structure.

Each part of the structure must—

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including—

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary to prevent the accumulation of corrosive, flammable, or noxious fluids.

§ 27.610 Lightning protection.

(a) The rotorcraft must be protected against catastrophic effects from lightning.

(b) For metallic components, compliance with paragraph (a) of this section may be shown by—

(1) Electrically bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the rotorcraft.

(c) For nonmetallic components, compliance with paragraph (a) of this section may be shown by—

(1) Designing the components to minimize the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current so as not to endanger the rotorcraft.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.611 Inspection provisions.

There must be means to allow the close examination of each part that requires—

(a) Recurring inspection;

(b) Adjustment for proper alignment and functioning; or

(c) Lubrication.

and (c) of this section, compliance with this paragraph must be shown by selecting design values that assure material strength with the following probability—

[(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99 percent probability with 95 percent confidence; and

[(2) For redundant structure, those in which the failure of individual elements would result in applied loads being safely distributed to other load-carrying members, 90 percent probability with 95 percent confidence.]

(c) The strength, detail design, and fabrication of the structure must minimize the probability of disastrous fatigue failure, particularly at points of stress concentration.

(d) [Design values must be those contained in the following publications (available from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120) or other values approved by the Administrator:]

(1) MIL–HDBK–5, "Metallic Materials and Elements for Flight Vehicle Structure".

(2) MIL–HDBK–17, "Plastics for Flight Vehicles".

(3) ANC–18, "Design of Wood Aircraft Structures".

(4) MIL–HDBK–23, "Composite Construction for Flight Vehicles".

[(e) Other design values may be used if a selection of the material is made in which a specimen of each individual item is tested before use and it is determined that the actual strength properties of that particular item will equal or exceed those used in design.]

(Amdt. 27–16, Eff. 12/1/78); [(Amdt. 27–26, Eff. 4/5/90)]

§ 27.619 Special factors.

(a) The special factors prescribed in §§ 27.621 through 27.625 apply to each part of the structure whose strength is—

27.625 apply, the factor of safety prescribed in § 27.303 must be multiplied by a special factor equal to—

(1) The applicable special factors prescribed in §§ 27.621 through 27.625; or

(2) Any other factor great enough to ensure that the probability of the part being understrength because of the uncertainties specified in paragraph (a) of this section is extremely remote.

§ 27.621 Casting factors.

(a) *General.* The factors, tests, and inspections specified in paragraphs (b) and (c) of this section must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Paragraphs (c) and (d) of this section apply to structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) *Bearing stresses and surfaces.* The casting factors specified in paragraphs (c) and (d) of this section—

(1) Need not exceed 1.25 with respect to bearing stresses regardless of the method of inspection used; and

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) *Critical castings.* For each casting whose failure would preclude continued safe flight and landing of the rotorcraft or result in serious injury to any occupant, the following apply:

(1) Each critical casting must—

(i) Have a casting factor of not less than 1.25; and

(ii) Receive 100 percent inspection by visual, radiographic, and magnetic particle (for ferromagnetic materials) or [penetrant] (for nonferromagnetic materials) inspection methods or approved equivalent inspection methods.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet—

and (3) of this section, the casting factors and corresponding inspections must meet the following table:

Casting factor	*Inspection*
2.0 or greater	100 percent visual.
Less than 2.0, greater than 1.5.	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), or approved equivalent inspection methods.
1.25 through 1.50.	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), and radiographic or approved equivalent inspection methods.

(2) The percentage of castings inspected by nonvisual methods may be reduced below that specified in paragraph (d)(1) of this section when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis—

(i) A casting factor of 1.0 may be used; and

(ii) The castings must be inspected as provided in paragraph (d)(1) of this section for casting factors of ''1.25 through 1.50'' and tested under paragraph (c)(2) of this section.

[(Amdt. 27–34, Eff. 11/28/97)]

§ 27.623 Bearing factors.

(a) Except as provided in paragraph (b) of this section, each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used on a part for which any larger special factor is prescribed.

§ 27.625 Fitting factors.

For each fitting (part or terminal used to join one structural member to another) the following apply:

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood); and

(2) With respect to any bearing surface for which a larger special factor is used.

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the section properties become typical of the member.

§ 27.629 Flutter.

Each [aerodynamic surface] of the rotorcraft must be free from flutter under each appropriate speed and power condition.

[(Amdt. 27–26, Eff. 4/5/90)]

ROTORS

§ 27.653 Pressure venting and drainage of rotor blades.

(a) For each rotor blade—

(1) There must be means for venting the internal pressure of the blade;

(2) Drainage holes must be provided for the blade; and

(3) The blade must be designed to prevent water from becoming trapped in it.

(b) Paragraphs (a)(1) and (2) of this section do not apply to sealed rotor blades capable of withstanding the maximum pressure differentials expected in service.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.659 Mass balance.

(a) The rotors and blades must be mass balanced as necessary to—

(1) Prevent excessive vibration; and

(2) Prevent flutter at any speed up to the maximum forward speed.

(b) The structural integrity of the mass balance installation must be substantiated.

(Amdt. 27–2, Eff. 2/25/68)

(a) [The reliability of the means for preventing ground resonance must be shown either by analysis and tests, or reliable service experience, or by showing through analysis or tests that malfunction or failure of a single means will not cause ground resonance.]

(b) The probable range of variations, during service, of the damping action of the ground resonance prevention means must be established and must be investigated during the test required by § 27.241.

(Amdt. 27–2, Eff. 2/25/68); [(Amdt. 27–26, Eff. 4/5/90)]

CONTROL SYSTEMS

§ 27.671 General.

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of any incorrect assembly that could result in the malfunction of the system.

§ 27.672 Stability augmentation, automatic, and power-operated systems.

If the functioning of stability augmentation or other automatic or power-operated systems is necessary to show compliance with the flight characteristics requirements of this part, such systems must comply with § 27.671 of this part and the following:

(a) A warning which is clearly distinguishable to the pilot under expected flight conditions without requiring the pilot's attention must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system which could result in an unsafe condition if the pilot is unaware of the failure. Warning systems must not activate the control systems.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must allow initial counteraction of failures without requiring exceptional pilot skill or strength

tions;

(2) The controllability and maneuverability requirements of this part are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and rotorcraft configurations) which is described in the Rotorcraft Flight Manual; and

(3) The trim and stability characteristics are not impaired below a level needed to permit continued safe flight and landing.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.673 Primary flight control.

Primary flight controls are those used by the pilot for immediate control of pitch, roll, yaw, and vertical motion of the rotorcraft.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.674 Interconnected controls.

Each primary flight control system must provide for safe flight and landing and operate independently after a malfunction, failure, or jam [of] any auxiliary interconnected control.

[(Amdt. 27–26, Eff. 4/5/90)]

§ 27.675 Stops.

(a) Each control system must have stops that positively limit the range of motion of the pilot's controls.

(b) Each stop must be located in the system so that the range of travel of its control is not appreciably affected by—

(1) Wear;

(2) Slackness; or

(3) Takeup adjustments.

(c) Each stop must be able to withstand the loads corresponding to the design conditions for the system.

(d) For each main rotor blade—

(1) Stops that are appropriate to the blade design must be provided to limit travel of the blade about its hinge points; and

must be means to—

(a) Give unmistakable warning to the pilot when the lock is engaged; and

(b) Prevent the lock from engaging in flight.

§ 27.681 Limit load static tests.

(a) Compliance with the limit load requirements of this part must be shown by tests in which—

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

§ 27.683 Operation tests.

It must be shown by operation tests that, when the controls are operated from the pilot compartment with the control system loaded to correspond with loads specified for the system, the system is free from—

(a) Jamming;

(b) Excessive friction; and

(c) Excessive deflection.

§ 27.685 Control system details.

(a) Each detail of each control system must be designed to prevent jamming, chafing, and interference from cargo, passengers, loose objects, or the freezing of moisture.

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) Cable systems must be designed as follows:

(1) Cables, cable fittings, turnbuckles, splices, and pulleys must be of an acceptable kind.

ley cable combinations and strength values which must be used are specified in Military Handbook MIL–HDBK–5C, Vol. 1 & Vol. 2[,] Metallic Materials and Elements for Flight Vehicle Structures, (Sept. 15, 1976, as amended through December 15, 1978). This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 USC Section 552(a) and 1 CFR part 51. Copies may be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120. Copies may be inspected at the FAA, Rotorcraft Standards Staff, 4400 Blue Mound Road, Fort Worth, Texas, or at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC.

(5) Pulleys must have close fitting guards to prevent the cables from being displaced or fouled.

(6) Pulleys must lie close enough to the plane passing through the cable to prevent the cable from rubbing against the pulley flange.

(7) No fairlead may cause a change in cable direction of more than 3°.

(8) No clevis pin subject to load or motion and retained only by cotter pins may be used in the control system.

(9) Turnbuckles attached to parts having angular motion must be installed to prevent binding throughout the range of travel.

(10) There must be means for visual inspection at each fairlead, pulley, terminal, and turnbuckle.

(e) Control system joints subject to angular motion must incorporate the following special factors with respect to the ultimate bearing strength of the softest material used as a bearing:

(1) 3.33 for push-pull systems other than ball and roller bearing systems.

(2) 2.0 for cable systems.

(f) For control system joints, the manufacturer's static, non-Brinell rating of ball and roller bearings must not be exceeded.

(Amdt. 27–11, Eff. 2/1/77); [(Amdt. 27–26, Eff. 4/5/90)]

§ 27.691 Autorotation control mechanism.

Each main rotor blade pitch control mechanism must allow rapid entry into autorotation after power failure.

§ 27.695 Power boost and power-operated control system.

(a) If a power boost or power-operated control system is used, an alternate system must be immediately available that allows continued safe flight and landing in the event of—

(1) Any single failure in the power portion of the system; or

(2) The failure of all engines.

(b) Each alternate system may be a duplicate power portion or a manually operated mechanical system. The power portion includes the power source (such as hydraulic pumps), and such items as valves, lines, and actuators.

(c) The failure of mechanical parts (such as piston rods and links), and the jamming of power cylinders, must be considered unless they are extremely improbable.

LANDING GEAR

§ 27.723 Shock absorption tests.

The landing inertia load factor and the reserve energy absorption capacity of the landing gear must be substantiated by the tests prescribed in §§ 27.725 and 27.727, respectively. These tests must be conducted on the complete rotorcraft or on units consisting of wheel, tire, and shock absorber in their proper relation.

§ 27.725 Limit drop test.

The limit drop test must be conducted as follows:

(a) The drop height must be—

(1) 13 inches from the lowest point of the landing gear to the ground; or

(2) Any lesser height, not less than eight inches, resulting in a drop contact velocity equal to the greatest probable sinking speed likely to be absorbed by it.

(d) When an effective mass is used in showing compliance with paragraph (b) of this section, the following formula may be used instead of more rational computations:

$$W_e = W \times \frac{h+(1-L)d}{h+d}; \text{ and}$$

$$n = n_j \frac{W_e}{W} + L$$

Where—

W_e = the effective weight to be used in the drop test (lbs.);

$W = W_M$ for main gear units (lbs.), equal to the static reaction on the particular unit with the rotorcraft in the most critical attitude. A rational method may be used in computing a main gear static reaction, taking into consideration the moment arm between the main wheel reaction and the rotorcraft center of gravity.

$W = W_N$ for nose gear units (lbs.), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the rotorcraft acts at the center of gravity and exerts a force of $1.0g$ downward and $0.25g$ forward.

$W = W_T$ for tailwheel units (lbs.), equal to whichever of the following is critical:

(1) The static weight on the tailwheel with the rotorcraft resting on all wheels; or

(2) The vertical component of the ground reaction that would occur at the tailwheel, assuming that the mass of the rotorcraft acts at the center of gravity and exerts a force of $1g$ downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions.

h = specified free drop height (inches).

L = ratio of assumed rotor lift to the rotorcraft weight.

d = deflection under impact of the tire (at the proper inflation pressure) plus the vertical component of the axle travels (inches) relative to the drop mass.

n = limit inertia load factor.

n_j = the load factor developed, during impact, on the mass used in the drop test (i.e., the acceleration dv/dt in g's recorded in the drop test plus 1.0).

§ 27.727 Reserve energy absorption drop test.

The reserve energy absorption drop test must be conducted as follows:

gear will not support the rotorcraft in the proper attitude or allows the rotorcraft structure, other than the landing gear and external accessories, to impact the landing surface.]

[(Amdt. 27–26, Eff. 4/5/90)]

§ 27.729 Retracting mechanism.

For rotorcraft with retractable landing gear, the following apply:

(a) *Loads.* The landing gear, retracting mechanism, wheel-well doors, and supporting structure must be designed for—

(1) The loads occurring in any maneuvering condition with the gear retracted;

(2) The combined friction, inertia, and air loads occurring during retraction and extension at any airspeed up to the design maximum landing gear operating speed; and

(3) The flight loads, including those in yawed flight, occurring with the gear extended at any airspeed up to the design maximum landing gear extended speed.

(b) *Landing gear lock.* A positive means must be provided to keep the gear extended.

(c) *Emergency operation.* When other than manual power is used to operate the gear, emergency means must be provided for extending the gear in the event of—

(1) Any reasonably probable failure in the normal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy.

(d) *Operation tests.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) *Position indicator.* There must be a means to indicate to the pilot when the gear is secured in the extreme positions.

(f) *Control.* The location and operation of the retraction control must meet the requirements of §§ 27.777 and 27.779.

(g) *Landing gear warning.* An aural or equally effective landing gear warning device must be provided that functions continuously when the rotor-

§ 27.731 Wheels.

(a) Each landing gear wheel must be approved.

(b) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with—

(1) Maximum weight; and

(2) Critical center of gravity.

(c) The maximum limit load rating of each wheel must equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this part.

§ 27.733 Tires.

(a) Each landing gear wheel must have a tire—

(1) That is a proper fit on the rim of the wheel; and

(2) Of the proper rating.

(b) The maximum static load rating of each tire must equal or exceed the static ground reaction obtained at its wheel, assuming—

(1) The design maximum weight; and

(2) The most unfavorable center of gravity.

(c) Each tire installed on a retractable landing gear system must, at the maximum size of the tire type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent contact between the tire and any part of the structure or systems.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.735 Brakes.

For rotorcraft with wheel-type landing gear, a braking device must be installed that is—

(a) Controllable by the pilot;

(b) Usable during power-off landings; and

(c) Adequate to—

(1) Counteract any normal unbalanced torque when starting or stopping the rotor; and

(2) Hold the rotorcraft parked on a 10° slope on a dry, smooth pavement.

§ 27.751 Main float buoyancy.

(a) For main floats, the buoyancy necessary to support the maximum weight of the rotorcraft in fresh water must be exceeded by—

(1) 50 percent, for single floats; and

(2) 60 percent, for multiple floats.

(b) Each main float must have enough water-tight compartments so that, with any single main float compartment flooded, the main floats will provide a margin of positive stability great enough to minimize the probability of capsizing.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.753 Main float design.

(a) *Bag floats.* Each bag float must be designed to withstand—

(1) The maximum pressure differential that might be developed at the maximum altitude for which certification with that float is requested; and

(2) The vertical loads prescribed in § 27.521(a), distributed along the length of the bag over three-quarters of its projected area.

(b) *Rigid floats.* Each rigid float must be able to withstand the vertical, horizontal, and side loads prescribed in § 27.521. These loads may be distributed along the length of the float.

§ 27.755 Hulls.

For each rotorcraft, with a hull and auxiliary floats, that is to be approved for both taking off from and landing on water, the hull and auxiliary floats must have enough water-tight compartments so that, with any single compartment flooded, the buoyancy of the hull and auxiliary floats (and wheel tires if used) provides a margin of positive stability great enough to minimize the probability of capsizing.

(b) If there is provision for a second pilot, the rotorcraft must be controllable with equal safety from either pilot seat; and

(c) The vibration and noise characteristics of cockpit appurtenances may not interfere with safe operation.

§ 27.773 Pilot compartment view.

(a) Each pilot compartment must be free from glare and reflections that could interfere with the pilot's view, and designed so that—

(1) Each pilot's view is sufficiently extensive, clear, and undistorted for safe operation; and

(2) Each pilot is protected from the elements so that moderate rain conditions do not unduly impair his view of the flight path in normal flight and while landing.

(b) If certification for night operation is requested, compliance with paragraph (a) of this section must be shown in night flight tests.

§ 27.775 Windshields and windows.

[Windshields and windows must be made of material that will not break into dangerous fragments.]

[(Amdt. 27–27, Eff. 10/22/90)]

§ 27.777 Cockpit controls.

Cockpit controls must be—

(a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and

(b) Located and arranged with respect to the pilots' seats so that there is full and unrestricted movement of each control without interference from the cockpit structure or the pilot's clothing when pilots from 5′2″ to 6′0″ in height are seated.

§ 27.779 Motion and effect of cockpit controls.

Cockpit controls must be designed so that they operate in accordance with the following movements and actuation:

a forward motion to increase power.

(c) Normal landing gear controls must operate downward to extend the landing gear.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.783 Doors.

(a) Each closed cabin must have at least one adequate and easily accessible external door.

(b) [Each external door must be located where persons using it will not be endangered by the rotors, propellers, engine intakes, and exhausts when appropriate operating procedures are used). If opening procedures are required, they must be marked inside, on or adjacent to the door opening device.]

[(Amdt. 27–26, Eff. 4/5/90)]

§ 27.785 Seats, berths, safety belts, and harnesses.

(a) Each seat, safety belt, harness, and adjacent part of the rotorcraft at each station designated for occupancy during takeoff and landing must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces and must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the static inertial load factors specified in § 27.561(b) and dynamic conditions specified in § 27.562.

(b) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object except as provided for in § 27.562(c)(5). A shoulder harness (upper torso restraint), in combination with the safety belt, constitutes a torso restraint system as described in TSO–C114.

(c) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot when seated with safety belt and shoulder harness fastened to perform all functions necessary for flight operations. There must be a means to secure belt and harnesses normal flight must be padded.

(f) Each seat and its supporting structure must be designed for an occupant weight of at least 170 pounds considering the maximum load factors, inertial forces, and reactions between occupant, seat, and safety belt or harness corresponding with the applicable flight and ground-load conditions, including the emergency landing conditions of § 27.561(b)). In addition—

(1) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in § 27.397; and

(2) The inertial forces prescribed in § 27.561(b) must be multiplied by a factor of 1.33 in determining the strength of the attachment of—

(i) Each seat to the structure; and

(ii) Each safety belt or harness to the seat or structure.

(g) When the safety belt and shoulder harness are combined, the rated strength of the safety belt and shoulder harness may not be less than that corresponding to the inertial forces specified in § 27.561(b), considering the occupant weight of at least 170 pounds, considering the dimensional characteristics of the restraint system installation, and using a distribution of at least a 60-percent load to the safety belt and at least a 40-percent load to the shoulder harness). If the safety belt is capable of being used without the shoulder harness, the inertial forces specified must be met by the safety belt alone.

(h) When a headrest is used, the headrest and its supporting structure must be designed to resist the inertia forces specified in § 27.561, with a 1.33 fitting factor and a head weight of at least 13 pounds.

(i) Each seating device system includes the device such as the seat, the cushions, the occupant restraint system, and attachment devices.

(j) Each seating device system may use design features such as crushing or separation of certain parts of the seats to reduce occupant loads for the emergency landing dynamic conditions of § 27.562; otherwise, the system must remain intact and must not interfere with rapid evacuation of the rotorcraft.

rotorcraft must be provided with a padded end-board, cloth diaphragm, or equivalent means that can withstand the forward load reaction. A berth or litter oriented greater than 15° with the longitudinal axis of the rotorcraft must be equipped with appropriate restraints, such as straps or safety belts, to withstand the forward load reaction. In addition—

(1) The berth or litter must have a restraint system and must not have corners or other protuberances likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) The berth or litter attachment and the occupant restraint system attachments to the structure must be designed to withstand the critical loads resulting from flight and ground load conditions and from the conditions prescribed in § 27.561(b).

(Amdt. 27–21, Eff. 12/6/84); (Amdt. 27–25, Eff. 12/13/89)

§ 27.787 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, except the emergency landing conditions of § 27.561.

(b) There must be means to prevent the contents of any compartment from becoming a hazard by shifting under the loads specified in paragraph (a) of this section.

(c) [Under the emergency landing conditions of § 27.561, cargo and baggage compartments must—

[(1) Be positioned so that if the contents break loose they are unlikely to cause injury to the occupants or restrict any of the escape facilities provided for use after an emergency landing; or

[(2) Have sufficient strength to withstand the conditions specified in § 27.561 including the means of restraint, and their attachments, required for the maximum authorized weight of cargo and baggage at the critical loading distribution.]

requested, the rotorcraft must meet the requirements of this section and §§ 27.807(d), 27.1411 and 27.1415.

(b) Each practicable design measure, compatible with the general characteristics of the rotorcraft, must be taken to minimize the probability that in an emergency landing on water, the behavior of the rotorcraft would cause immediate injury to the occupants or would make it impossible for them to escape.

(c) The probable behavior of the rotorcraft in a water landing must be investigated by model tests or by comparison with rotorcraft of similar configuration for which the ditching characteristics are known. Scoops, flaps, projections, and any other factor likely to affect the hydrodynamic characteristics of the rotorcraft must be considered.

(d) It must be shown that, under reasonably probable water conditions, the flotation time and trim of the rotorcraft will allow the occupants to leave the rotorcraft and enter the life rafts required by § 27.1415. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowances must be made for probable structural damage and leakage. If the rotorcraft has fuel tanks (with fuel jettisoning provisions) that can reasonably be expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(e) Unless the effects of the collapse of external doors and windows are accounted for in the investigation of the probable behavior of the rotorcraft in a water landing (as prescribed in paragraphs (c) and (d) of this section), the external doors and windows must be designed to withstand the probable maximum local pressures.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.807 Emergency exits.

(a) *Number and location.* Rotorcraft with closed cabins must have at least one emergency exit on the opposite side of the cabin from the main door.

(b) *Type and operation.* Each emergency exit prescribed in paragraph (a) of this section must—

(3) Have a simple and obvious method of opening and be arranged and marked so as to be readily located and operated, even in darkness; and

(4) Be reasonably protected from jamming by fuselage deformation.

(c) *Tests.* The proper functioning of each emergency exit must be shown by test.

(d) [Ditching emergency exits for passengers. If certification with ditching provisions is requested, one emergency exit on each side of the fuselage must be proven by test, demonstration, or analysis to—

[(1) Be above the waterline;

[(2) Have at least the dimensions specified in paragraph (b) of this section; and

[(3) Open without interference from flotation devices whether stowed or deployed.]

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–21, Eff. 12/6/84); [(Amdt. 27–26, Eff. 4/5/90)]

§ 27.831 Ventilation.

(a) The ventilating system for the pilot and passenger compartments must be designed to prevent the presence of excessive quantities of fuel fumes and carbon monoxide.

(b) The concentration of carbon monoxide may not exceed one part in 20,000 parts of air during forward flight or hovering in still air. If the concentration exceeds this value under other conditions, there must be suitable operating restrictions.

§ 27.833 Heaters.

Each combustion heater must be approved.

(Amdt. 27–23, Eff. 10/3/88)

FIRE PROTECTION

§ 27.853 Compartment interiors.

For each compartment to be used by the crew or passengers—

(a) The materials must be at least flash resistant;

from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when smoking is prohibited. Signs which notify when smoking is prohibited must—

(i) When illuminated, be legible to each passenger seated in the passenger cabin under all probable lighting conditions; and

(ii) Be so constructed that the crew can turn the illumination on and off.

(Amdt. 27–17, Eff. 3/6/80)

§ 27.855 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be constructed of, or lined with, materials that are at least—

(1) Flame resistant, in the case of compartments that are readily accessible to a crewmember in flight; and

(2) Fire resistant, in the case of other compartments.

(b) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that—

(1) They cannot be damaged by the movement of cargo in the compartment; and

(2) Their breakage or failure will not create a fire hazard.

§ 27.859 Heating systems.

(a) *General.* For each heating system that involves the passage of cabin air over, or close to, the exhaust manifold, there must be means to prevent carbon monoxide from entering any cabin or pilot compartment.

(b) *Heat exchangers.* Each heat exchanger must be-

(1) Of suitable materials;

(2) Adequately cooled under all conditions; and

(3) Easily disassembled for inspection.

[(c) *Combustion heater fire protection.* Except for heaters which incorporate designs to prevent hazards in the event of fuel leakage in the heater least one adequate discharge to all areas of the heater region.

[(3) Complete drainage of each part of each zone to minimize the hazards resulting from failure or malfunction of any component containing flammable fluids. The drainage means must be—

[(i) Effective under conditions expected to prevail when drainage is needed; and

[(ii) Arranged so that no discharged fluid will cause an additional fire hazard.

[(4) Ventilation, arranged so that no discharged vapors will cause an additional fire hazard.

[(d) *Ventilating air ducts.* Each ventilating air duct passing through any heater region must be fireproof.

[(1) Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct.

[(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be so constructed or isolated from that system that the malfunctioning of any component of that system cannot introduce flammable fluids or vapors into the ventilating airstream.

[(e) *Combustion air ducts.* Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation.

[(1) No combustion air duct may connect with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunction of the heater or its associated components.

[(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

[(f) *Heater control: General.* There must be means to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

of the following occurs:

[(i) The heat exchanger temperature exceeds safe limits.

[(ii) The ventilating air temperature exceeds safe limits.]

(iii) The combustion airflow becomes inadequate for safe operation.

(iv) The ventilating airflow becomes inadequate for safe operation.

(2) The means of complying with paragraph (g)(1) of this section for any individual heater must—

(i) Be independent of components serving any other heater, the heat output of which is essential for safe operation; and

(ii) Keep the heater off until restarted by the crew.

(3) There must be means to warn the crew when any heater, the heat output of which is essential for safe operation, has been shut off by the automatic means prescribed in paragraph (g)(1) of this section.

(h) *Air intakes.* Each combustion and ventilating air intake must be located so that no flammable fluids or vapors can enter the heater system—

(1) During normal operation; or

(2) As a result of the malfunction of any other component.

(i) *Heater exhaust.* Each heater exhaust system must meet the requirements of §§ 27.1121 and 27.1123.

(1) Each exhaust shroud must be sealed so that no flammable fluids or hazardous quantities of vapors can reach the exhaust system through joints.

(2) No exhaust system may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(j) *Heater fuel systems.* Each heater fuel system must meet the powerplant fuel system requirements affecting safe heater operation. Each heater fuel system component in the ventilating airstream must be protected by shrouds so that no leakage from hazardous ice accumulation under any operating condition.

(Amdt. 27–1, Eff. 6/4/67); [(Amdt. 27–23, Eff. 10/3/88)]

§ 27.861 Fire protection of structure, controls, and other parts.

[Each part of the structure, controls, rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be fireproof or protected so they can perform their essential functions for at least 5 minutes under any foreseeable powerplant fire conditions.]

[(Amdt. 27–26, Eff. 4/5/90)]

§ 27.863 Flammable fluid fire protection.

(a) In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of rotorcraft components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(a) [It must be shown by analysis or test, or both, that the rotorcraft external load attaching means can withstand a limit static load equal to 2.5, or some lower factor approved under §§ 27.337 through 27.341, multiplied by the maximum external load for which authorization is requested. The load is applied in the vertical direction and in any direction making an angle of 30° with the vertical, except for those directions having a forward component. However, the 30° angle may be reduced to a lesser angle if—]

(1) An operating limitation is established limiting external load operations to such angles for which compliance with this paragraph has been shown; or

(2) It is shown that the lesser angle can not be exceeded in service.

(b) The external load attaching means for Class B and Class C rotorcraft-load combinations must include a device to enable the pilot to release the external load quickly during flight. This quick-release device, and the means by which it is controlled, must comply with the following:

(1) A control for the quick-release device must be installed on one of the pilot's primary controls and must be designed and located so that it may be operated by the pilot without hazardously limiting his ability to control the rotorcraft during an emergency situation.

(2) In addition a manual mechanical control for the quick-release device, readily accessible either to the pilot or to another crewmember, must be provided.

(3) The quick-release device must function properly with all external loads up to and including the maximum external load for which authorization is requested.

(c) A placard or marking must be installed next to the external-load attaching means stating the maximum authorized external load as demonstrated under § 27.25 and this section.

[(d) The fatigue evaluation of § 27.571(a) does not apply to this section except for a failure of

There must be reference marks for leveling the rotorcraft on the ground.